April 14, 2021

Filed electronically through **www.regulations.gov**, Docket Number FAA-2021-0037

Mr. Donald Scata
Office of Environment and Energy
Federal Aviation Administration, DOT

**RE: Comments on the Federal Aviation Administration's Overview of FAA Aircraft Noise Policy and Research Efforts: Request for Input on Research Activities to Inform Aircraft Noise Policy**

Dear Mr. Scata:

We (J.J. Alonso, T.C. Rindfleisch, and D.C. Jackson) as the Principal Investigators of the Metroplex Overflight Noise Analysis (MONA) project, appreciate the opportunity to submit these comments regarding the Federal Aviation Administration's (FAA) Overview of FAA Aircraft Noise Policy and Research Efforts: Request for Input on Research Activities to Inform Aircraft Noise Policy; Docket ID No. FAA-2021-0037.

The overarching goal of the MONA project is to carefully measure and analyze the ground noise generated by aircraft overflights and to provide accurate and actionable data to inform consensus-building and policy-making efforts involving aircraft noise and the impacts of the FAA's NextGen procedure changes. While our initial work is focused on the San Francisco Bay Area metroplex, we have developed MONA so that it can be applied anywhere else in the US and around the world. Given the complex interdependencies between the noise levels perceived on the ground and the air traffic patterns that create aircraft noise, a secondary goal of MONA is to share, through compelling visualizations, our results with broad communities of stakeholders to help generate consensus and reach better decisions more quickly.

In the *Federal Register* notice opening this docket, the FAA specifically asked for comments on the following questions:

1. What, if any, additional investigation, analysis, or research should be undertaken in each of the following three categories:
   A. Effects of Aircraft Noise on Individuals and Communities
   B. Noise Modeling, Noise Metrics, and Environmental Data Visualization
   C. Reduction, Abatement, and Mitigation of Aviation Noise

2. What other factors (e.g., survey methodology, aircraft design, and social/demographic considerations) may contribute to the increase in annoyance shown in the NES results?
3. What, if any, additional categories of investigation, analysis, or research should be undertaken to inform FAA noise policy?

Our comments on each question/item above follow.

**1-A: Effects of Aircraft Noise on Individuals and Communities**

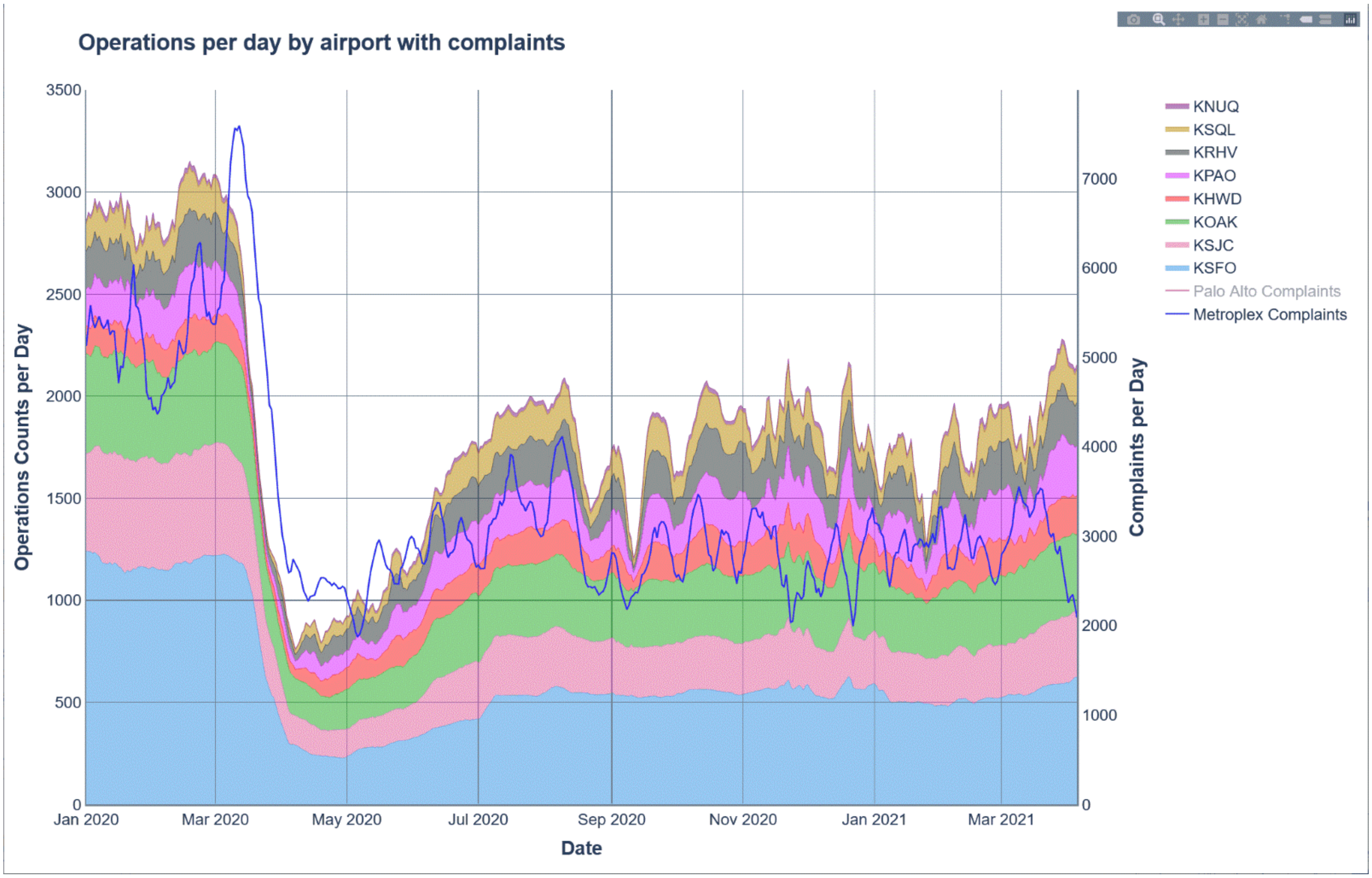
We suggest that there are two distinct types of impacts of aircraft noise, in

1. Areas with High-Noise Levels (HNL) close to airports, and
2. Areas with Numerous/Frequent Overflights (NFO), often extending as far as 40 miles from an airport boundary.

The DNL metric with a threshold value of 65 dBA is used as the measure of significant impact for the areas of "High-Noise Levels". Although these areas have not been the focus of our work to date, the abundance of evidence from similar studies in other countries (particularly within the European Union), from historical complaint trends around major metropolitan airports, and from the results of the NES itself, lead us to suggest that the FAA should re-evaluate the use of the 65 dBA threshold and that a more appropriate threshold level should be found to reflect the current situation.

The FAA also uses the DNL metric + 65dB threshold to measure and assess the impact in areas/corridors with "Numerous/Frequent Overflights" and consequently, all FAA environmental reviews result in a "Finding of No Significant Impact" (FONSI), which seems clearly out of touch with the dramatic increase in the number of noise complaints by the public. The Aviation Safety and Noise Abatement Act mandates that the FAA utilize noise metrics that have "a highly reliable relationship between projected noise exposure and surveyed reactions of people to noise." The use of DNL-65 currently fails this requirement mainly in areas with "Numerous/Frequent Overflights", and this conclusion is further supported by the NES findings.

The coronavirus pandemic provided an unexpected, and of course unfortunate, natural experiment to study the impact of significantly-decreased aircraft traffic levels on individuals and communities in the San Francisco Bay Area and around the world. During the entire time, the MONA project has collected metroplex-wide ADS-B data within a radius of 100 miles of Stanford University and has measured the daily volume of aircraft operations in and out of each of three major international airports and five regional airports. A stacked plot of operations from January 1, 2020 through April 5, 2021 is shown below.




The precipitous drop in traffic volume starting March 17, 2020, is the result of the COVID-19 lockdown. The traffic dropped from 100% pre-lockdown to 30% in mid-April and has recovered after July to about 55% of the pre-lockdown level.

An additional available metric is the near real-time complaint system `stop.jetnoise.net` that runs on any cell phone and allows Bay Area residents to register annoyance at the time of any overflight event at their discretion. The blue line in the plot above shows the overall metroplex complaint volume as a function of time, before and after the lockdown. It dropped in almost perfect proportion to the drop in traffic volume.

While further investigations are certainly needed, the correlation is obvious: the same types of aircraft, flying the same approach and departure routes, in aggregate, reduced the complaint volume by 50% from up to 6,000 per day (pre-lockdown) to about 3,000 per day (as traffic has begun to recover) while the traffic decreased to 55% of its original level. Two event-based metrics, (a) overflight events and (b) ground-based complaints, are found to be almost perfectly correlated and clearly illustrate the profound impact of the frequency of air traffic on ground observer annoyance.

During the same period, the DNL levels measured at our ground monitors positioned under one of the main approach routes to SFO, dropped from about 52 dB to 49 dB, i.e., to about 92% of the pre-lockdown level. These data, in addition to other evidence from our work, suggest to us that the link between the frequency of overflight traffic and the level of annoyance should not be ignored and that the FAA ought to seriously investigate other metrics beyond the traditional DNL to assess, predict, and understand the impact of overflight noise on residents in metroplex areas. Only by using metrics that are better correlated with the realities of how noise is perceived today will the FAA be able to make steady progress with the implementation of NextGen procedures, while minimizing noise impacts and equitably distributing the inevitable remaining levels of aircraft noise.

We respectfully recommend that the FAA adopt a new, non-DNL metric for assessing impacts in areas with “Numerous/Frequent Overflights”.

Our ideas and suggestions are described in the following section.

**1-B: Noise Metrics**

As a result of our work, we have found that the Number-Above-Noise-Level (NANL) metric is the best predictor of impacts and annoyance in areas of "Numerous/Frequent Overflights", a finding also supported by FAA-funded research.

In addition to the standard full-day NANL, we find that fractional-day NANL metrics provide increased correlation with annoyance and complaints, for example, the maximum of the NANLs for each hour of a day.

This leads us to recommend that NANL-type metrics should be routinely reported over a variety of geographic divisions, including:

- City, County, and US Congressional District boundaries,
- Standardized uniform geometric grids, where we believe the FAA should adopt the (free) H3 hexagonal hierarchical geospatial indexing system for use in its noise prediction and visualization software (specifically AEDT).

NANL values can also be weighted by the population of the overflown areas to measure and assess the total number of people impacted.

We suggest that the FAA adopt and utilize NANL-based metrics for environmental review of areas that experience "Numerous/Frequent Overflights" at large distances from the airport, where the concentration of flight routes appears to have caused significantly-higher impacts than was predicted using traditional metrics.

The NES describes the availability of the study's datasets. As far as we can tell, to date, the public has not been provided access.  For this reason, and so that the data can be analyzed by many capable teams around the US, we request the FAA release the PII-free version of the datasets as soon as possible.

**1-B: Noise Modeling**

We use FAA's AEDT and TARGETS software in our research, and propose a number of possible improvements to streamline noise predictions and their correlation with annoyance:

- Integrate and incorporate higher-accuracy, state-of-the-art noise modeling options into AEDT, such as NASA's ANOPP2 or other suitable alternatives.
- Enable AEDT to seamlessly utilize actual flight trajectories (as captured via ADS-B) when predicting noise. Currently AEDT's default behavior is to alter the input flight trajectories to conform to standardized flight profiles which do not represent the actual aircraft trajectories, resulting in less accurate noise predictions.
- Support the H3 hexagonal hierarchical geospatial indexing system as an additional AEDT receptor-grid option.
- Transition AEDT and TARGETS from PC-centric applications to a modern client-server implementation, where the server portion can run on standard cloud and server operating systems, specifically Linux/Unix, and the front-end graphic user interactions are provided via web browsers. All program functionality/capabilities should be accessible via network APIs, and not limited to direct user interaction via its graphical interface.
- Provide AEDT and TARGETS software at no cost to US citizens, this software was developed with taxpayer money, and should be freely available to them.
- Open source the AEDT and TARGETS software, via GitHub (or equivalent). Currently FAA software development is limited to DOT employees and its contractors, (e.g., the Volpe Center, MITRE). These internal developers do a very reasonable job given their limited number and resources, but development progress is slow, and does not compare favorably with that of many open-source projects. The benefits of open-source development are summarized by Joy's Law (Bill Joy) that "all the smart people don't work for you." Open-sourcing AEDT and TARGETS would enable researchers and software developers to contribute enhancements and improvements to these tools.
- Transition AEDT's use of proprietary, costly technologies (e.g., Microsoft SQL Server and ArcGIS) to equivalent free and open-source alternatives, (e.g., PostgreSQL and PostGIS).

**1-B: Environmental Data Visualization**

The data visualization capabilities of FAA's AEDT and TARGETS tools do not compare favorably with the current state-of-the-art; provide non-integrated, overlapping, and redundant functionality; and are based on older PC-centric technologies whose results are not easily and directly sharable via the web. Because of these issues, it becomes increasingly hard to share complex information with a broad set of stakeholders, thus slowing down the consensus-building process.

We recommend that FAA visualization tools transition to web-browser-based interfaces. In our work we have found the free and open source deck.gl library to be a powerful and effective tool for developing geospatial visualizations.  We recommend the FAA base future visualization functionality on this (or similar) technology.

Future FAA data visualization tools should include support for metric aggregation by geographic region, including city, county, congressional district boundaries, and support the H3 hexagonal hierarchical geospatial indexing system.

**1-C: Reduction, Mitigation, and Abatement of Aviation Noise**

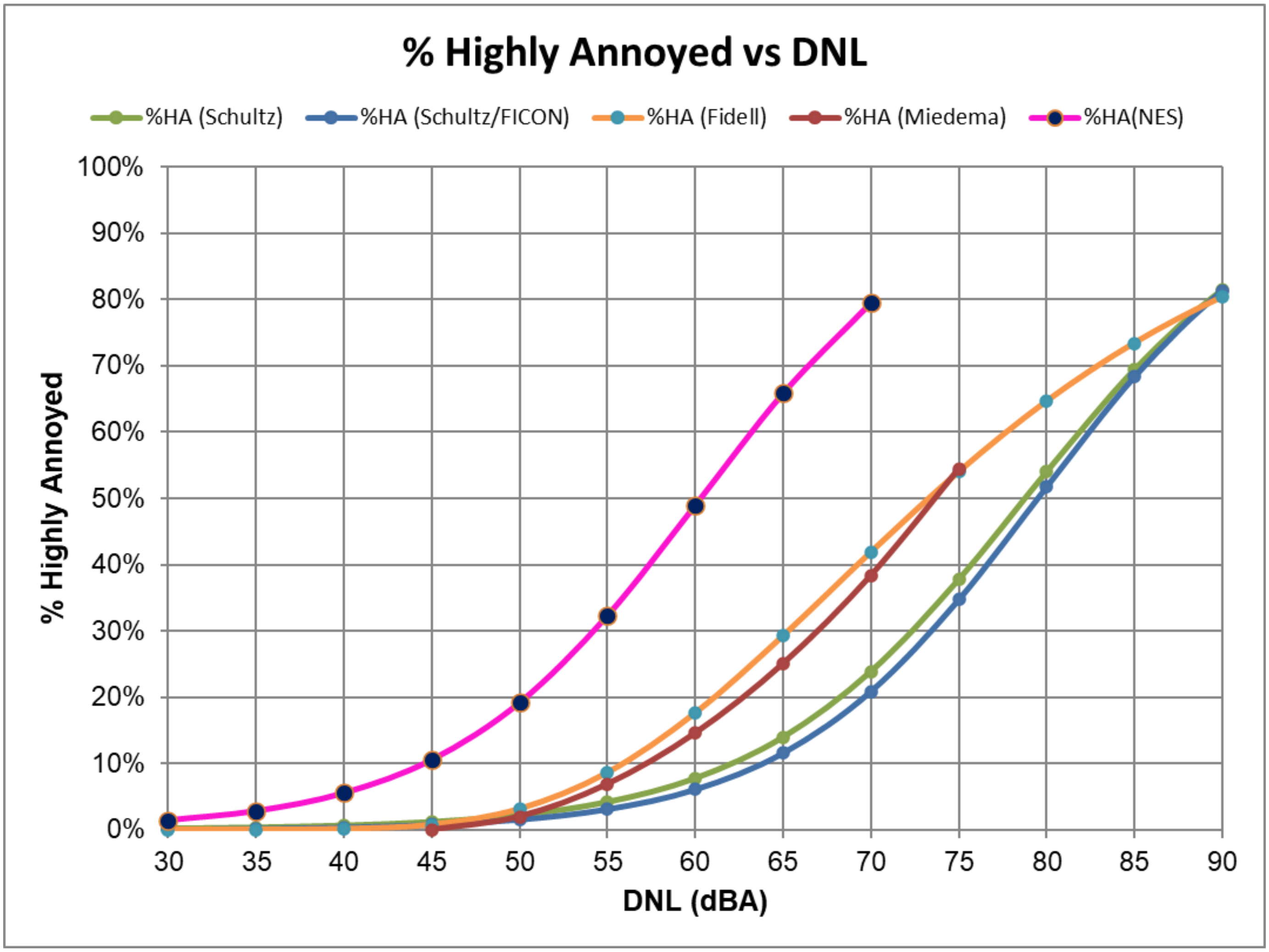
At present, the "High Noise Levels" close to the airport trigger mandated mitigation and abatement solutions including:

- Window replacement
- Increased insulation
- Flight curfews

The impacts of "Numerous/Frequent Overflights" further from the airport require different solutions.  We propose that procedure re-design utilize dispersion, branching, altitude flexibility, and carefully choose overflown areas, and that they focus on the equitable distribution of aircraft overflights on a per capita basis as the primary approach for future noise mitigation/abatement.

**2: Additional Factors Contributing to the Increase in Annoyance Shown in the NES Results**

We believe that the question should not be "Why has there been an increase in annoyance shown in the NES results," but rather why has it taken so long (50 years) to understand that the initial Schultz curve, as confirmed by FICON in 1992, badly underestimated the relation between annoyance and the chosen sound level metric (dBA DNL). The figure below shows the progression of dose-response fits of % Highly Annoyed to DNL.




The Schultz and Schultz/FICON curves were derived from studies in the 1970s and 1992. The Miedema and Fidell curves were published in 1998 and 2004, respectively. The NES curve was published in 2021. From this progression, it is clear that indications of higher annoyance levels were emerging from the study data several decades ago.

To relate the essence of these curves, consider the DNL levels (D50) at which 50% of those exposed were annoyed. For the Schultz/FICON curves D50 = 78.9 dB. For the Miedema/Fidell curves D50 = 73.5 dB. And for the NES curve, D50 = 60.3 dB. In retrospect it seems inconceivable that only 50% of adults with normal hearing exposed to an average sound energy level per second of 80 dB, would be annoyed. The Miedema/Fidell 50% level is also very conservative. Given the complaint and air traffic data that we have analyzed, the NES 50% highly annoyed level appears to be much closer to what we would expect and is hardly surprising.

In addition, we believe the following factors may also contribute to the increase in annoyance shown in the NES:

- NextGen's PBN-enabled narrowing and concentration of procedure routes
- Use of lower altitudes in arrival routes than those used prior to NextGen
- Procedure-speed target requirements necessitating the use of noise-generating speed-reduction flight operations
- Increased vectoring to achieve aircraft spacing and arrival time commitments
- The overall increase in aircraft traffic over time
- Modern digital communication tools (e.g., smartphones, social media, and the world-wide web) make it easier to express one's annoyance, rather than writing a letter, making a telephone call, or filing a lawsuit each time annoyance becomes unreasonable.

## 3: Additional Categories of Investigation, Analysis, or Research Should be Undertaken to Inform FAA Noise Policy

We strongly believe that, from this point forward, all aviation noise measurements and predictions should include Number-Above-Noise-Level metric results, at a variety of noise levels, and including the fractional-day NANL variants proposed above. In fact, it is unlikely that a single metric will suffice or that a universal dose-response curve will be broadly applicable. Conditions vary significantly from metroplex to metroplex depending on the regional housing insulation norms, the level of ambient noise in an industrial city versus a suburban environment, the density of housing, and so on.

Additionally, existing noise-related datasets such as those underpinning the NES should be re-processed to generate and publish NANL metric results.

FAA metric research and analysis should focus on how best to use NANL (and the variants we suggested above) to best predict annoyance, and to inform procedure design to equitably disperse and allocate noise impacts of aviation.

If procedure dispersion would require enhancements or upgrades to air-traffic-controller visualization and monitoring tools, and/or upgrades to flight management systems aboard aircraft, identifying, specifying, and beginning these developments should be a high priority.

## Closing:

We appreciate the FAA’s request for input on these questions and topics, and we look forward to thoughtful FAA action based on the significant results of the NES, and the public comments received in this docket.

## Signed:


- Juan J Alonso
- Thomas C Rindfleisch
- Donald C Jackson

Principal Investigators of the Metroplex Overflight Noise Analysis (MONA) project


*The opinions expressed in this document are those of the above-signed individuals and do not represent the views of any employer or other group that they are affiliated with.*